Report 2021

Task 39

Photo: Andrea Vignaroli

Quiet Wind Turbine Technology

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Wind turbine noise is recognized as a key factor in social acceptance of wind energy.

THE GOAL OF IEA Wind TCP Task 39 is to accelerate the development and deployment of quiet wind turbine technology and consolidate understanding of wind turbine sound emission, propagation, and ultimately its perception by residents as well as their attitude toward the noise. The approach is two-folded. On one hand, technical experts are convened to investigate various aspects of modelling, measurement, assessment techniques, as well as regulatory aspects in the field of wind turbine noise to improve our general understanding of these various interacting factors. On the other hand, the best available information on quiet wind turbine technologies should be made available to all stakeholders, from decision makers and regulators to developers. Wind

Table 1. Countries Participating in Task

	COUNTRY	INSTITUTION(S)
1	**Denmark**	DTU, SGRE, Vestas, FORCE
2	**Ireland**	NUIGalway, ULimerick, RPS Consulting
3	**Germany**	DLR, IAG & IFB Stuttgart, GE, Enercon, 3DS, MSH Hamburg, UHannover, IWES Franhaufer, TUMunchen, RWE
4	**The Netherlands**	TNO, TUDelft, UTwente, UHanze, Lagerwey
5	**Sweden**	KTH

In addition to the above countries, a number of countries have expressed their interest in participating to Task 39 and/or have joined Task meetings but are not fully committed yet. These countries and organizations are (non-exhaustively): Canada (HGC Engineering, Aercoustics), China (Goldwind, CGC), Finland (Poyry), Switzerland (Prona SA), UK (ION Acoustics, Hayes McKenzie, RWE, Hoare Lea), USA (NREL, CH2M UCDavis).

turbine noise experts in various fields of expertise originating from different countries are active in the Task endeavor to reach these goals. The activities are distributed in 4 WPs addressing engineering aspects on one side (noise generation and noise propagation) and socio-psychological aspects on the other side (assessment of noise effects on humans and perception of noise related to other factors that noise itself). Furthermore, documents, including fact sheets on specific topics, are being drafted and should provide valuable and up-to-date technical information in an easily accessible format to a larger audience. The first phase of Task 39 officially ended in 2020. The second phase of the Task is currently undergoing with an increased focus on human perception and acceptance issues.

Introduction

Societal acceptance of new technologies is key to their successful adoption. In some jurisdictions, there is concern about the potential impact of wind turbine noise. The goal of IEA Wind TCP Task 39 is to accelerate the development and deployment of quiet wind turbine technology and consolidate understanding of wind turbine sound emission, propagation, and ultimately its perception by residents in terms of noise impact and annoyance, but also psychological perception and acceptance. The Task will convene an international expert panel to identify best practices in the prediction, measurement, and assessment of noise, as well as investigate regulatory aspects.

The first objective is to ensure that the best available information on quiet noise technology is available to consultants, regulators, and developers to contribute to relevant international standards and government regulations. A second objective is to promote collaborative work between researchers across different countries on selected topics relevant to wind turbine noise related technologies. The collaboration is carried out in a series of focused work packages (WPs). The first one is concerned with dissemination. Two WPs deal with engineering aspects, namely noise emission at the turbine level and noise propagation from the turbine to the dwellings across the atmospheric medium. Two additional WPs are concerned with the human aspects related to wind turbine noise. One addresses the psycho-acoustical aspects and the physical perception of noise, as well as methods to quantify the objective annoyance and means to regulate noise emissions from wind farms, e.g., through penalty schemes. The last WP aims at characterizing the external influences not related to noise on the noise perception that may yield to additional annoyance and hinder social acceptance of wind energy.

There has been broad participation in Task meetings involving experts in a diversity of disciplines in industry, consultancy, and research. Remote participation and presentations in meetings, facilitated through web conferencing, have served to extend participation to a wider group of experts. In addition, there has been in-kind contributions, in term of active participation to sub-tasks from the Task work program, from several of the countries involved (formally or not, see below) in the Task activities. However, three countries have officially committed to participate in the Task with agreement from relevant governmental organizations that grant participation to IEA Wind TCP activities (see Table 1).

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Progress and Achievements

The first work package focuses on Interdisciplinary Education and Guidance. The corresponding activities have recently concentrated on the writing of two fact sheets and two technical documents. These documents are currently being drafted and reviewed by international experts in their respective fields. A Catalogue of International Wind Turbine Noise International Wind Turbine Noise Limits and Regulations will be published online so that they can be interactively updated by experts in the field.

The second and third WPs deal with physical and technical aspects of wind turbine noise emission and sound propagation. Various activities have been initiated and are ongoing: a wind turbine noise simulation codes benchmark conducted in collaboration with Task 29/47 - the creation of a database of aerodynamic and noise measurements for the validation of a model for a serrated airfoil with measurement campaigns conducted in 5 acoustic wind tunnel facility - the study of blade tip noise with wind tunnel noise measurements and model developments - several benchmark test-cases have been defined to compare propagation models of different fidelity, as well as for different situations (e.g., offshore vs. onshore conditions).

The third and fourth work package is concerned with the psycho-acoustic aspects of wind turbine noise. Both groups are populated by experts from the fields of engineering and psychology. It was highlighted at an early point that the group might need to develop an efficient knowledge exchange program, so experts from different backgrounds could communicate effectively. For example, annoyance is an important concept in both fields, but depending on one's background, the discussions on annoyance might deviate into one field. To address this issue, a seminar featuring presentations from experts in both Engineering and Psychology was held and followed by an open discussion forum. This seminar is available for all Task Members to view. This knowledge exchange will be through a shared working document (hosted on the on Open Science Framework (https://osf.io) to enable effective collaboration and joint definitions of technical concepts. The aim is that this working document will form a state-of-the-art report on best practices in the area of wind farm annoyance.

Highlights

A first recent highlight is the initiation of a series of virtual meetings convening experts with a various background ranging from engineering to psychology, including participants in Task 28 – Acceptance. The idea is to exchange technical knowledge between the attendees, providing a cross-disciplinary perspective on wind turbine noise and issues specific to each discipline. Ideally, these exchanges may lead to collaboration between researchers from these different disciplines.

Following the trends in aeronautics,

Fig. 1: Swept blade tip measured in a DTU-PLC wind tunnel.

future wind turbines will most probably be equipped with similar devices such as winglets. A new Task activity focuses on the noise generated by blade tips. It consists of a noise measurement campaign that was recently conducted in a DTU-PLC wind tunnel (See Fig. 1). The measurement data will be used for high-fidelity model validation, as well as the development of engineering models for blade tip design.

Outcomes and Significance

From a general point of view, developing noise mitigation technologies and recommending best practices for regulatory and siting processes is regarded as an important step toward public acceptance. This should eventually facilitate the deployment of wind energy. IEA Wind Task 28 has already advanced the potential for enhanced community engagement to address such problems. The new activities related to the psychology of noise will support the study of the acceptance of wind energy by the public.

On the engineering side, the benchmarking and comparisons of models between research institutes and industry contribute to improving the design tools for quiet wind turbine design and their siting. This should also help in developing best practices on how to use these tools. Furthermore, the review report on existing noise regulations worldwide may provide a valuable overview for policy-makers, especially in countries in the early stage of wind energy deployment.

Next Steps

The first 3-year phase of Task 39 has officially ended at the end of the year 2020. The second phase of the Task has just started, and new activities with a larger focus on the psychology of noise, such as perception and social aspects.

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